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lytical geometry are restricted." In pure geometry we start with a small number of so-called "primitive forms," and, from the simple relations obtaining between these, proceed to forms of the second order, and so on. The generality and comprehensiveness of the results, which are not based solely on metrical considerations, are such that the most important of the properties of conic sections proved in the text-books of analytical geometry are merely special cases of its theorems.

The preliminary knowledge necessary for the prosecution of synthetic geometry is not great; a profound knowledge of the old geometry is not required; but skill in producing mental images of geometric forms without the use of diagrams is important, as is also a knowledge of perspective or central projection, as well as of descriptive geometry generally. Conversely, the study of synthetic geometry is a great help to the prosecution of the last-mentioned studies themselves.

Its distinctive educational result would be, therefore, to enhance the development of the power of imagination, for which its study can be particularly recommended. The author believes that this is best obtained by the method of Von Staudt which "excludes all calculations, be they complicated or not, which make no demands upon the imagination," and "arrives at the knowledge of the geometric truths upon which he bases the geometry of position, by direct visualisation." But, in absolutely discarding diagrams, and other auxiliaries of the visualising sense, Reye has not followed Von Staudt. He has not sought to increase the difficulties of the subject.

The tendency of all recent educational methods lies in this direction: the utmost development of the powers of sense and consequent imagination. Here lies the basis on which the abstract must build, and the more perfect that basis the more solid will be the superstructure. The most powerful pleas of the greatest of recent mathematicians have been made for "visualisation"; and it is to be hoped that the present beautiful volume will mark, in English-speaking countries also, a distinct stage in the progress towards this goal. T. J. McCormack.

La Géométrie grecque. Comment son histoire nous est parvenue et ce que nous en savons. Essai Critique. By *Paul Tannery*. Première Partie: Histoire générale de la géométrie élémentaire. Paris: Gauthier-Villars. 1887. Pages, 188+vi. Price, 4 fr. 50 c.

Recherches sur l'histoire de l'astronomie ancienne. By *Paul Tannery*. Paris: Gauthier-Villars. 1893. Pages, 370+viii. Price, 6 fr.

The researches of M. Paul Tannery in the history of ancient mathematical and physical science are well known. To call wider attention to his investigations we should like to mention two of his works in this field. The first of the books listed at the head of this notice deals with the traditions which prevailed on the history of geometry among the Greeks. For a knowledge of Greek geometry proper, says the author, we must study the writings of Euclid, Archimedes, Apollonius, and Pappus; but for the history of the science we must go to other sources; and to give a methodical criticism of these sources has been his object. He would ascertain how these traditions have been formed, how they have been transmitted, upon what data they originally rested, what is their degree of general probability, etc. Such a task is a condition precedent to any attempt to write the history of Greek mathematics. but it is a task which has not yet been accomplished, at least for the science at large.

The treatment centers necessarily about Proclus, but is by no means limited to this author. The work is divided into fourteen chapters, devoted to such subjects as the following: The Epoch of Geminus; the Classification of Mathematics according to Geminus; the Applications of Geometry in Antiquity; the Tradition concerning Pythagoras; the Elements of Euclid; Hippocrates of Chios; the Technology of the Elements of Euclid; the Successors of Euclid; Hero; and so forth.

The second volume mentioned is mainly consecrated to giving a complete and exact analysis of the great *Almagest* of Ptolemy which is the epitome and codification of the astronomical knowledge of the ancients. The author has sought to trace from a new point of view the entire development of the positive astronomical knowledge of the Greeks, and has also insisted upon the difference between the successive conceptions which have been formed of celestial science. He has been obliged to omit the consideration of what he regards an important factor in this process; namely, the great influence which was exerted on the progress of real astronomical knowledge and on the formulation of theoretical questions by the various superstitions prevailing in antiquity with regard to the stars, and particularly by the superstitions of the official astrology. The opportunity for the full treatment of this question he deems not yet ripe, inasmuch as a sufficient number of cuneiform texts has not yet been deciphered to exhibit the Chaldean doctrines in their entirety, and to enable us to distinguish in their astrology what was original from what is modern. Also, for the opinions of the early Greek physiologers, he refers the reader to his celebrated work, *Pour l'histoire de la science hellène* (Paris: Félix Alcan. 1887).

A further effort of M. Tannery has been to separate in the *Almagest* the original contributions of Ptolemy from those of his predecessors, particularly of Hipparchus. Even the contributions of Hipparchus to astronomical science appear to M. Tannery to have been greatly exaggerated. Without the labors of the earlier astronomers of the Alexandrian school,—and especially those of Apollonius,—Hipparchus wonld have been unable to accomplish the best part of the work which has made him immortal. And without Hipparchus, Ptolemy could never have composed his *Almagest*. The history of ancient astronomy, therefore, presents *an aspect of continuity* from Eudoxus to Hipparchus, and the conception of such a development is far more natural and comprehensible than that of the entire constitution of the science by a single man, as it is pictured in so many books to-day.

There are fifteen chapters, the subjects being: (1) The Greek Conception of Astronomy; (2) The Greek Conception of Astrology; (3) The Mathematics of Alexandria; (4) The Postulates of Astronomy According to Ptolemy; (5) The Sphericity of the Earth; (6) The General Movement of the Planets; (7) The Circles of the Sphere; (8) The Length of the Solar Year; (9) The Tables of the Sun; (10) The Periods of Hipparchus for Lunar Movements; (11) The Tables of the Moon; (12) The Parallaxes of the Sun and the Moon; (13) The Prediction of Eclipses (14) The Theory of the Planets; and (15) The Catalogue of the Fixed Stars.

An appendix contains a number of studies on important special points, and also a translation of an Arabic treatise by M. De Vaux on Celestial Spheres. *μκρκ*

COURS COMPLET DE MATHÉMATIQUES ÉLÉMENTAIRES. Publié sous la direction de *M. Darboux*, doyen de la Faculté des Sciences de Paris. Paris: Armand Colin et Cie., 5 rue de Mézières.

Leçons d'Arithmétique théorique et pratique. Par *Jules Tannery*. Large 8vo. Pp., 510. Price, 5 fr.

Leçons de Géométrie (Géométrie plane). Par *Jacques Hadamard*. Large 8vo. Pp., 308. 6 fr.

Leçons d'Algèbre élémentaire. Par M. C. Bourlet. Large 8vo. Pp. 550. 7 fr. 50.

Leçons de Trignométrie rectiligne. Par *M. C. Bourlet*. Large 8vo Pp., 322. 6 fr.

Leçons de Cosmographie. Par MM. *Tisserand* et *H. Andoyer*. Large 8vo. Pp., 370. 6 fr.

The new "complete course of elementary mathematics" now publishing in France under the supervision of M. Darboux, member of the Institute and dean of the Faculty of Sciences at Paris, is in many respects a notable one, and, as the expression of one of the most significant reforms of modern education, deserving of the best attention of American and English instructors of mathematics, as well as of all others interested in this study. The language of the books is easy, and the commonest reading knowledge of French will suffice for access to this unique store of knowledge, compiled by some of the best of modern specialists under the direction of one of the most distinguished of living mathematicians. The books are instinct with the modern spirit, are thoroughly alive to the exigencies of present life and practice, and are remarkably cheap. In addition, they deviate so widely from the inherited routine practices of American and English text-book making as to furnish, through this feature alone, a powerful stimulus to the student or teacher.

The first volume is the *Arithmetic* of M. Tannery (510 pages),—a complete, detailed and accurate exposition of the science, not containing everything under the sun, nor being a digest of everything ever written on the subject, but in the main practical and natural despite its insistence on method and the mass of apparent superfluities which so large a work must contain. It goes to the kernel of its subjects, begins with the concrete, proceeds gradually to the abstract, seeks to illuminate the *technique* of operations by the exposition of the logic at the bottom of